AMATEUR SATELLITE REPORT

Number 133
September 30, 1986

Editor: Vern Riportella, WA2LQQ
Contr. Editors:
Eric Rosenberg, WA6YBT
Pete Killingsworth, KD7WZ
Paul Roemer, KG6LC
Managing Editor: Bob Myers, W1XT

AMSAT's® *Newsletter for the Amateur Radio Space Program*

Amateur Satellite Report is endorsed by the American Radio Relay League as the special interest Newsletter serving the Amateur Radio Satellite Community

Copyright 1986 by AMSAT® , The Radio Amateur Satellite Corporation. AMSAT® is a registered trademark.

Team To Propose Permanent Amateur Facility On Space Station

In an historic meeting, representatives of NASA, AMSAT and ARRL met recently to begin a long-term program which could lead to Amateur Radio literally being built into the NASA Space Station instead of being added-on later. Leaders of the SAREX (Shuttle Amateur Radio Experiment) and others met at the ARRL National Convention in San Diego September 6 to discuss initial ideas on what Astronaut Dr. Tony England, WØORE, is calling the SSAR Project for Space Station Amateur Radio. The SSAR program will be one of the longest ever undertaken in Amateur Radio running from concept to fruition at least nine years. The Space Station is currently slated to fly in 1995.

The meeting was organized by Roy Neal, K6DUE, of NBC News as a follow-on to his pivotal work in the SAREX missions and his work with Astronaut Owen Garriott, W5LFL on the Ham-In-Space program. Dr. Tony England, WØORE, recently stepped into Owen's position within NASA's Space Station program upon Owen's recent retirement. Tony co-hosted the meeting with Roy. Representing AMSAT were Chairman, John Browning, W6SP; President, Vern Riportella, WA2LQQ; and Vice President For Manned Space Operations, Bill Tynan, W3XO. On hand for the ARRL were its President, Larry Price, W4RA; First Vice President, Jay Holladay, W6EJJ; Executive Vice President, Dave Sumner, K1ZZ and International Affairs VP, Tod Olson, KØTO.

SSAR Kickoff meeting. San Diego ARRL 1986 National Convention. (l-r) KØTO, K1ZZ, WØORE, W6SP, K6DUE, WA2LQQ, W4RA, W3XO. Not pictured, W6EJJ.

A working group was organized to develop the basis for a plan which would lead to a formal proposal to NASA during 1987. AMSAT will be the lead agency in the working group for the first steps. Then, when tasks are identified in the proposal effort, ARRL may appoint a task leader and assume the lead role.

According to WØORE's view of the project, it could play a strong role in developing interests in students for engineering, mathematics and science education. Tony's views on this subject are zealous and similar to those of W5LFL before him.

WØORE also emphasized the pivotal role an AMSAT geosynchronous capability could have on SSAR success. Tony pointed out that since the Space Station's orbital inclination will be 28.5 degrees, it will need the potential relay capability an AMSAT Phase 4 system could provide to reach the more extreme northerly and southerly latitudes.

The SSAR program has an excellent chance of flying according to knowledgeable sources. Senior NASA officials are well-familiar with both the OSCAR and the prior SAREX programs. They are said to view them very favorably and thus would seem amenable to building on them further.

Efforts To Save AO-10 Continue With Some Success

A team of specialists from Europe, North America and the South Pacific continued intense work to regain control of AO-10 in recent days. Their efforts have yielded some encouraging results. However, it now seems inevitable that AO-10 will undergo an uncontrolled power-down soon due to worsening sun-angles.

Seasonal changes will reduce solar power to zero as the earth-satellite system makes its way around the sun. That could happen by mid-October if attitude change efforts are unsuccessful. If, on the other hand, a magnetorquing routine can be executed in the next week or so, the power-down episode might be postponed for a few months.

There are a number of views as to precisely which approach is best-suited to the current and anticipated scenario. All agree however, that the root cause of the problem is radiation damage to the IHU memory. There is some data

to suggest a few days without power in space will "anneal" the NMOS RAMs. They could then regain much of there functionality after such a power down. Earlier concern about freezing the main or auxiliary battery has dissipated, however, since there is now data to show the batteries will survive anticipated temperature extremes. Moreover, since the main batteries have now been in use more than 3 years, they are much less likely to do untoward things like reverse polarize themselves later when power is restored. By early November the batteries may begin to recharge and AO-10 could be back in limited service.

Odds that AO-10 will survive and be useful again after eclipse are rated not better than 50-50. (and not worse than 50-50!)

Working the problem on the special command and engineering team are Ron Dunbar, WØPN; Graham Ratcliff, VK5AGR; Ian Ashley, ZL1AOX; Peter Guelzow, DB2OS, and Randy Smith, VE1SAT. Ralph Wallio, WØRPK, is special liaison to the team.

In accord with the guidance of the command team, this is an especially critical juncture in the AO-10 rescue attempt. While the new software package is being developed, the transponder may inadvertently be turned on. Please resist the temptation and do not use the transponders on AO-10 until further notice. It would be especially wise to closely monitor all AMSAT Nets for recent developments in the AO-10 rescue effort. Urgent, late-breaking bulletins can also be heard on ARRL station W1AW during its regularly scheduled bulletin sessions.

In sum, much has been learned about the condition of the IHU memory with the novel approach developed by WØPN. Much work is yet to be done however. The next step would seem to be an attempt at magnetorquing. If nothing changes, however, October 15 is nominally doomsday for AO-10. Whether it comes back later in another incarnation will be a matter of what we know, what we can do and a considerable component of good fortune!

Harris To Donate Special Rad-Hard Memory For Phase 3C

Harris Corporation of Melbourne, Florida has agreed to supply AMSAT with special memory modules for its Phase 3C spacecraft. The modules are especially radiation-hardened and qualified as Class S parts; suitable for space use. The parts are Harris HS-6564RH modules. Each consists of sixteen 4k by 1 bit rad-hard synchronous CMOS static RAMs. AMSAT will organize the modules to provide 32k bytes of 12 bit wide memory to its 1802 CPU. This is twice the memory now on AO-10. The HS-6564RH is latchup free and able to absorb 100,000 rads (Si) total dose.

The current problems with AO-10 originate with its NMOS memory. The MOSTEK 4116 RAMS just were not designed for space application. But they were the best AMSAT could afford at the time Phase 3B (later to become AO-10) was under construction. To bolster the 4116 rad-hardness, each chip was fitted with a special tantalum applique. Then the entire memory was encased in a brass box. The choice of tantalum and brass was made based on analysis of possible secondary emission energy bands. The two metals are somewhat complementary in that sense.

The new Harris modules are produced by Harris's Custom Integrated Circuit Division (CICD) in Melbourne. Initial contact with Harris's CICD Program Manager, Joel Alcorn, was made by AMSAT's Harold Winard, KB2M. Harold is a free-lance electronics editor who was aware of AMSAT's current problems with AO-10 and Harris's rad-hard product line.

Plans call for KB2M and AMSAT President, Vern "Rip" Riportella, WA2LQQ, to visit Harris late in September to accept the donation of 10 modules valued at nearly $80,000 on behalf of the Phase 3C team of AMSAT and AMSAT DL.

Meanwhile in Colorado, Gordon Hardman, KE3D, is making swift work of building up a completely new Integrated Housekeeping Unit (IHU; the computer) for Phase 3C. The current flight unit which uses the same 4116 NMOS memories as AO-10 will be replaced by the new unit KE3D is building if the tight delivery schedule can be met. Phase 3C is due to go to shake and vibration testing in Germany soon. It is necessary the new IHU and memory be in place prior to "shake and bake" testing.

Help has also come from Andy Deskur, KA1M, who located the original artwork for the IHU and supplied it to KE3D recently. Gordon is building up the new IHU and memory using commercial Harris memory modules. When the new Harris rad-hard parts are available at month's end, they will be substituted for the commercial, non-rad-hard parts. The unit will then be tested and shipped to AMSAT DL for integration with Phase 3C.

With 32k of IHU memory aboard Phase 3C, many more features can be programmed in Phase 3C's IHU memory compared to AO-10's 16k memory. Features such as extensive telemetry menus, RTTY bulletins, orbital data dumps and yet-to-be-determined functions could be provided by the expanded memory capacity on Phase 3C.

Current launch schedule for Phase 3C is August, 1987. No firm date has yet been established.

Space Symposium and Annual Meeting Registration Opens

AMSAT will hold its Fourth Annual Space Symposium and Annual Meeting at the Dallas/Fort Worth Airport Hilton Hotel November 7-9. Speakers at the Saturday Symposium include experts from around the world who will address the latest in OSCAR news including FO-12, Phase 3C and the new Phase 4 Program. Featured speaker is Dr. Marty Davidoff, K2UBC, satellite expert and author of the popular Satellite Experimenter's Handbook.

The bountiful banquet prize list is capped by a new ICOM 1271A transceiver. The early registrant's prize list includes an ALINCO ALM-203T 2 meter HT worth $345. Early registration is now open. Mail in the application you recently received with your ballot for a chance at the ALINCO 2 meter HT! And, with over $3000 in prizes and banquet awards, this event could be very rewarding in more ways than one! Send the form in today. For further information you may call AMSAT Headquarters at 301-589-6062.

The Planning Committee is doing a superb job of preparing for your visit with the best of Texas-style hospitality. This could be the best meeting ever, so y'all come down to Dallas this November 7, 8 and 9.

Short Bursts

• FO-12 users without computer tracking capability can use the ARRL locator with a new ground track template that's available from AMSAT. Since the altitude of FO-12 is close to the RS satellites, you can use the range circles for the RS birds provided in the ARRL OSCARLOCATOR package. You'll need a new ground track, though, since the inclination of FO-12 is 50 degrees compared to 83 degrees for the RS birds. A template for the FO-12 ground track scaled for use with the OSCARLOCATOR can be obtained from AMSAT for an SASE to AMSAT, P.O. Box 27, Washington, D.C. 20044. There is no charge to AMSAT members supplying their member number. All others need include $2.00 in check or money order. All donations are appreciated.

• The WØRPK-AMSAT dial-in bulletin board has handled 1460 calls from AMSAT members and other interested parties since it became operational on 28 June. Currently there are 220 registered users from 40 states, 5 Canadian provinces and 7 countries. The best DX is Australia. The user list continues to grow at a rate of approximately 10 new users per week.

The WØRPK-AMSAT bulletin board can be accessed by calling 515-961-3325. On file is the latest AMSAT news, orbital elements and other technical topics of interest to OSCAR operators. Users are encouraged to provide wider dissemination of AMSAT information offered by this service by relaying what they find to packet radio and other Amateur Radio bulletin boards. There is no charge for this service. On the other hand, donations to AMSAT from appreciative system users are rarely turned away!

Recent AMSAT Field Reports

AMSAT Area Coordinators are at peak form as summer convention and hamfest activity folds into autumn. Typical of the efforts are the following.

At the Central Pennsylvania Radio Association Hamfest August 24, reports Assistant Area Coordinator John Gayman, WA3WBU, nearly 800 enthusiastic persons attended at the Harrisburg QTH. AMSAT was well-represented with Eric Rosenberg, WA6YBT, Joe Spandler, K3SZH and Norman Shuey, WA3TKU and WA3WBU teaming up for the effort. Exhibits in the AMSAT booth included demonstrations of tracking software, audio recordings of OSCAR QSOs, and lots of goodies from the new AMSAT catalog. Many familiar and lots of new faces were seen at the AMSAT booth. Many stopped by to learn what was new with AMSAT and the Amateur Space Program. A satellite forum was held which featured a comprehensive slide show. It was followed by a question and answer session.

In Lakewood, Colorado, Area Coordinator Joe Flaska, WBØRLY, set up shop with help from Hal Hebert, W8FAR and Chic Myers, KAØHPP, on August 10. The RMRL Swapfest was attended by more than 700 according to Joe. On display at the AMSAT tables were tracking programs and photos of Phase 3C construction activities. At the AMSAT seminar some 2 dozen attendees saw slides and listened to descriptions of the Phase 3C construction activities recently concluded in Colorado.

Organizers are encouraged to report on hamfests, conventions and swapmeets which have an AMSAT activity using the report forms supplied by Chief Area Coordinator, Mike Crisler, N4IFD. (or make up your own report form) Mail to *ASR* Editorial Office, P.O. Box 177, Warwick, NY 10990. Field activity reports will be given prompt *ASR* coverage commensurate with available space.

Geo-Sync System Possible In 4 Years AMSAT Says

The dream of an easily accessible amateur satellite communications system apparently has taken a giant step forward. In a concept for the next generation satellites AMSAT sees intercontinental QSOs via HTs, high-speed packet trunks and even digital ATV by decade's end.

The Phase 4 system would build on the experience drawn from 25 years of OSCARs. (OSCAR 1 was launched in December 1961). The latest bird to be built, Phase 3C, is being completed now in Europe by AMSAT DL and is scheduled for launch next autumn as a replacement for the ailing AMSAT OSCAR 10. The European Space Agency's V21 mission, the first Ariane-4 launch, will carry Phase 3C and two other spacecraft.

AMSAT Engineering Vice President Jan King, W3GEY, has just completed a so-called "Phase 4 Technical Study Plan" by which AMSAT hopes to determine the viability of a concept for a pair of geo-synchronous AMSAT satellites. The study plan was recently sent to AMSAT Directors and members of the special Phase 4 Engineering Study Team. The study team is charged to validate and optimize King's system architecture. The Directors, responsible for AMSAT policy, will evaluate the plan in light of organizational goals. After an approximately 1 year study, AMSAT Directors may be asked to authorize initial construction activities leading to a launch and full operations in the 1990-1991 time frame depending on launch availability.

According to King, the main thrust of Phase 4 should be Public Service. Only in this way, he says, can the program work. Phase 4 needs the support of a much broader coalition of amateurs than has ever previously thought of itself as satellite communicators according to King. And, significantly, amateurs need to promptly justify their use of (especially) the UHF spectrum; a resource of incalculable worth!

One government estimate quoted in the study plan says exclusive commercial use of a single megahertz of UHF spectrum has a total potential worth of "ONE BILLION" dollars. With that much of an attraction, says King, hams have to do a much better job of justifying their spectrum occupancy or they will surely be displaced by hungry commercial interests eyeing every kilohertz. And a public service satellite system that really SERVES is one of the best ways to insure we justify our use of the spectrum says King.

To garner that support the Phase 4 Study Plan proposes a multi-transponder package using the 2 meter, 70 cm, 24 cm and 13 cm bands. Features would include linking selected repeater teleports through the satellite for dial-up intercity or intercontinental communications between station-

ary or mobile platforms...even HTs; a dedicated high-speed packet transponder for linking terrestrial regional networks into a semi-global network; a linear transponder for SSB and CW; a special facility for ATV using digitized video and, for the UHF experimenters, a microwave beacon experiment.

There would even be the facility to transmit emergency bulletins to an entire hemisphere from a national or regional emergency operations center. "Receive-Only" teleports or gateway repeaters by the thousands could be linked to receive the emergency bulletins upon receipt of a special alert code transmitted via satellite. The network thus established would comprise one of the most robust networks anywhere and would be available to support emergency operations from sub-regional to national extent. Simple 1 meter dishes aimed at the satellite with inexpensive integrated LNA/mixers at the feed would suffice to capture the 13 cm downlink. With a broad interest, many manufacturers will respond eagerly to the new market.

While the traditional linear transponder-type access, Frequency Division Multiple Access (FDMA) will continue in the form of a Mode JL transponder, the emphasis of Phase 4 clearly will be on ease of access, convenience, predictability and, important for the emergency communications community, reliability and availability; it'll be there when/as required to support emergency operations. And the traditional bugaboos of tracking and predicting access will be gone since one will merely aim one's antennas at a given spot in the sky...and "weld" them in place!

With AMSTAR East positioned over the equator at 47 degrees West longitude and AMSTAR West at 145 degrees, the combined footprint would include everything from Tokyo and Melbourne east to Tel Aviv and Durban with continuous, 24 hour coverage and no tracking required! With cross-linking either directly between the birds or via a ground relay, packets launched in Milan would arrive in Auckland in a moment. Mobiles in Trafalgar Square could easily chat with pedestrians on Mount Shasta or Mauna Kea or Mount Fuji! There may even be a capability to link the SSAR (Space Station Amateur Radio facility) into AMSTAR.

While all this is preliminary and needs to be validated and refined by the Phase 4 Engineering Team, King's Study Plan is the first definitive plan which seriously addresses the engineering, conceptual and philosophical issues involved. Running in parallel with the engineering study will be the "Ways and Means" group. It will determine ways of financing the ambitious program and ultimately providing the "means". King estimates the cost at "over a megabuck"; about 6 dB$ more than AMSAT OSCAR 10 cost! An Operations Planning Group will begin looking at ways to use the tremendous resource contemplated and feed into the engineering group ways to optimize specific characteristics of the spacecraft to anticipated user requirements.

AMSAT says it will be briefing leaders in the Amateur Radio community on the overall Phase 4 plan over the next several months. It is especially interested in developing liaison with emergency communications and other public service-oriented organizations. ATVers, microwave experimenters, repeater organizations and especially repeater consortia who have a long-term interest and who might be interested in a risk-sharing partnership with AMSAT are sought. AMSAT says that while Phase 4 is a long-term program, early indicators of interest and helpful suggestions are most welcome even now. Write to AMSAT, Phase 4 Program Manager, P.O. Box 27, Washington, D.C. 20044.

SA AMSAT'S Contribution To The OSCAR Satellite Project ***by Hennie Rheeder, ZS6ALN***

(Adapted from SA AMSAT's SATELLITE COMMUNICATIONS, July 1986 by WA6YBT)

SA AMSAT's ambition to build a satellite was partially realized when AMSAT, USA, approached us to design and construct an S and L Band antenna combination for Phase 3C.

The first antenna built was designed by Professor Wynand Louw of the Department of Electronic and Computer Engineering at the University of Pretoria. This was a planar antenna. The performance at S-band was very satisfactory and a horizontal planar array was envisaged. Very good communication via electronic mail (Telemail) ensured quick feedback from AMSAT. AMSAT was very interested in the concept but unfortunately it turned out to be impractical to mount this type of antenna on a satellite because the thermal transfer of the satellite skin would be adversely affected.

It was suggested to try having one helix inside the other. This was followed up; Professor Louw went back to the drawing board. Two helices were made with opposite polarization: the S-band antenna inside the L-band antenna. The coupling between the two for 1269 and 2.4 GHz was less than -20 dB. Everything seemed fine until a radiation pattern was plotted. The maximum gain of the L-band antenna seemed to be 11 dBi with 1 dB ripple for circular polarization, as was expected.

However, problems cropped up at mid-band frequencies. The gain of the L-band antenna dropped by 2 dB and the S-band by as much as 10 dB. It is suspected that this arises from mutual interference of the antennas with greater effect at the higher frequencies. The exercise was very worthwhile as we were working in virgin soil!

The S-band helix was removed and the remaining L-band helix tested for use on both bands. The results were disappointing and unsatisfactory. A helix was then specifically designed and built for broadband purposes. This helix proved well-matched for both L and S-band using a single feedpoint. Again, the polar radiation plot proved us wrong! The specified gain, greater than 10 dBic, was never reached.

Because of the tight schedule for Phase 3C, a back-up S-band helix was built and tested at the same time. This antenna had 11 dBic gain and a reflection coefficient of -18dB or VSWR less than 1.5:1 at 2.4 GHz. The design specification called for 15 dB gain. Adjustments have been made to the design and a final unit is being built. The 11 dB unit was dispatched for AMSAT's comments. Some minor technical changes were suggested.

For an L and S-band combination antenna we are persevering and investigating a tapered helix design. It must be borne in mind that a 2m/70cm omni-directional antenna has to be accommodated inside this combination.

We would like to record our sincere appreciation to the Department of Electronic and Computer Engineering, University of Pretoria for its support.

The Modes of OSCAR: Historical Perspective

by Andy MacAllister, WA5ZIB

How about a two-meter repeater in space, or perhaps Mode "C" in orbit? Consider a satellite with a 15 meter uplink and a 10 meter downlink. Thoughts on the future? No, it's all history!

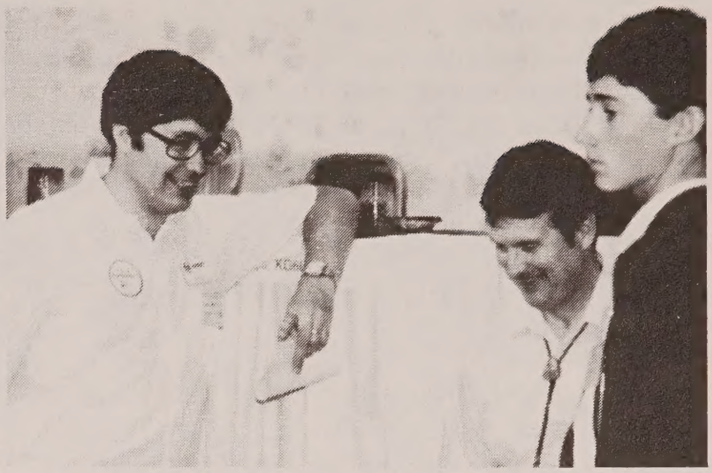
For the last few years, most amateur satellite enthusiasts have had only a few operating "modes". These included Mode "A" via the Russian (Radio) satellites with two-meter uplinks and 10-meter downlinks, Mode "B" on AMSAT OSCAR 10, with 70 cm up and 2 meters down and now "JA" activity with Fuji OSCAR 12. "JA" stands for mode "J" analog with 2 meters up and 70 cm down. It's the reverse of "B".

But what is the background of these "Modes"?

The first Amateur Radio transponder in space was onboard OSCAR 3. It was similar to a linear two-meter translator with an input at the low end of the band, and output just 1.8 MHz higher. It was a two-meter repeater in space. OSCAR 4 had a VHF-UHF transponder with a 2 meter input and a 70 cm output. It was the first Amateur crossband satellite.

Our first long-life satellite was AMSAT OSCAR 6, using the now familiar 2 meter uplink and 10 meter downlink system. AMSAT OSCAR 7, launched in 1974, had two transponders and four modes of operation. These four modes were logically called "A", "B", "C", and "D" and were the output states of two control flip-flops. Significantly, this labeling initiated generic transponder labels. Mode "A" referred to the 2 meter to 10-meter link, "B" was the 70-cm to 2 meter system and "C" represented reduced-power "B" operation. Mode "D" was simply the battery recharge mode. AMSAT OSCAR 8 was to be a simple replacement for OSCAR 6, but thanks to JAMSAT (the Japanese affiliate of AMSAT), it also carried a mode "J" transponder with a 2 meter uplink and a 70 cm downlink similar in concept to that on board the short-lived OSCAR 4.

Col. John Clowe, W4ZPG, Georgia AAC and Maria Billings at Atlanta Hamfest July 19.



Speakers at the Youth Forum at the ARRL National Convention 6 Sept. included (l-r) Harold Price, NK6K; Tony England, WØORE; Scott Springate, N7DDM.

The same year AMSAT OSCAR 8 was launched (1978), two Russian satellites, RS-1 and RS-2 were placed into higher (1700 km) altitude circular polar orbits. These were Mode "A" devices and were the first "HAMSATS" from the Soviet Union. The receivers were extremely sensitive but were also very susceptible to overload. The transponders didn't last long but the RS-1 beacon on 29.4 MHZ has been heard at times even in 1986 transmitting garbled CW data. In 1981 we greeted six new "RS" birds from a single launch. Two were 10 meter beacons (RS-3 and 4), two had Mode "A" transponders (RS-6 and 8) but the final two (RS-5 and 7) had both transponders and on-board "ROBOTS". These Robots made their serial-numbered CW QSO's from "Cosmic Space", as the QSL's read.

A year later, ISKRA's 2 and 3 (student experimental satellites) were deployed from Salyut-7. Neither satellite lasted long; only about two months for ISKRA-2 and a little over one month for ISKRA-3. It was, however, the first attempt at Mode "K" as the Russians called it. The transponders were to have 15 meter uplinks with 10 meter downlinks. Although ISKRA-3 had heat problems, an oscillating power regulator and a blown transistor, some Mode "K" success was reported in Europe, while ISKRA-2 was never commanded out of the beacon mode. The Russian RS series has provided the starting point for many newcomers looking for a taste of satellite activity without making a large commitment of money and time. RS-5, 6, 7 and 8 functioned quite well with reasonable coverage and reliable operation.

Mode "B" on AMSAT OSCAR 10 has offered us a chance to communicate via satellite with others for hours on end. Due to a transponder malfunction, AO-10's Mode "L" (24 cm up, 70 cm down) did not become the new mode of preference. A few hundred stations worldwide managed to achieve the additional 10 to 15 dB uplink power requirement forced by the failure of a bias regulator in the downlink transmitter. For most, however, Mode "L" remained just a curiosity.

Today we still have Mode A operation on RS-7 and occasionally RS-5. With FO-12 in orbit, many long-time satellite enthusiasts have come back "on-line", while newcomers are discovering the interesting characteristics of a "J" style transponder. FO-12 delights us with a highly functional and

fascinating medium for reliable, but short, contacts. We have yet to realize the potential of mode "JD", the digital mode on this new satellite. The possibilities are exciting. And how about "T", "JL" and "S"? In an upcoming article we'll examine these modes of the future which will offer unique challenges to the avid satellite chaser in years to come.

Crystals For IC-402 Enable Portable FO-12 Reception

Has anyone worked the new Fuji OSCAR 12 from a portable installation? We haven't heard any reports yet but here's your chance to be the first. Owners of ICOM's popular portable 432 MHz transceiver, the IC-402, can receive the downlink from Fuji OSCAR 12 simply by plugging a new crystal into one of the transceiver's two spare crystal sockets. Harold Winard, KB2M, reports that the Mode JA downlink can be heard using just a quarter-wave whip.

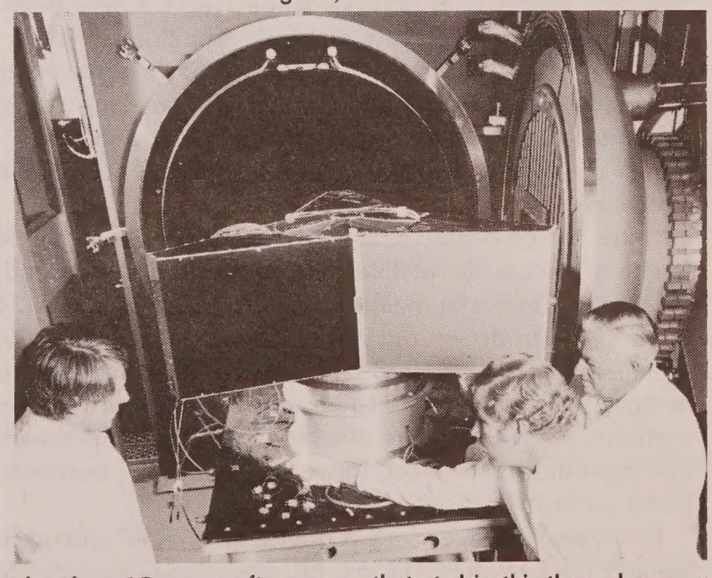
The Bomar Crystal Company says they have the necessary crystal frequency and circuit data to make the appropriate crystal. For cost and ordering information, write the company's sales department at: Bomar Crystal Company, 201 Blackford Ave., Middlesex, NJ 08846-2598, or call Mary Ann Reed at (201) 356-7787. For reception of the Mode JA transponder, the operating frequency should be specified as 435.800 MHz. Remember to mention that you heard about Bomar Crystal from AMSAT.

Working the AMSAT booth in San Diego 6 Sept. were WB6GFJ (with FOØFB shirt), WA6VGS and N6TE, both behind monitor.

AMSAT®

The Radio Amateur Satellite Corporation

Post Office Box 27
Washington, DC 20044



The Phase 3C spacecraft was recently tested in this thermal vacuum chamber facility provided by Martin-Marietta, Denver. Left to right are W3GEY, AAØP, WBØRLY.

(Martin-Marietta Photo)

Non-Profit Organization Second Class POSTAGE PAID at Waterbury, Conn.

LM-1096 KA6M 99.81
MAGNUSKI, HANK
2019 BARBARA DR.
PALO ALTO CA 94303

Amateur Satellite Report (ISSN 0889-6089) is published biweekly for $16 (inseparable from annual membership dues of $24) by AMSAT, Post Office Box 27, Washington, DC 20044. Second class postage paid at Silver Spring, MD and additional mailing offices. POSTMASTER: send address changes to *Amateur Satellite Report*, Post Office Box 27, Washington, DC 20044.